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Factors Affecting the Quality of Canned Apple Sauce[1,2]

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Apple sauce has been processed commercially in the United States since about 1920. Approximately 10 million bushels or close to 25 per cent of the apples used by industry are converted into sauce. This industry is concentrated mainly in three sections of the United States; the Central Appalachian area, which comprises parts of Maryland, Pennsylvania, Virginia and West Virginia; New York State; and the three Pacific Coast States. The Appalachian section is the most important single area and produces half of the National pack (2).

The objectives of the research reported here were: to ascertain the effects of variety, storage duration, storage type (cold or common) and maturity on the quality of single variety and blends of apple sauce; to determine possible relationships between the physical make-up and chemical constituents of the raw apple and the quality of the processed sauce; to determine those factors of sauce quality which have the greatest influence on the overall grade of the sauce; and to determine if certain objective instruments can be related to the subjective appraisals of the sauce.

Materials and Methods

1955–56 Season

Raw Product Handling—Five apple varieties, Stayman, Golden Delicious, York Imperial, Rome Beauty and Northwest Greening were harvested in the fall of 1955. Apples of 2½ to 3 inches in diameter were picked at a medium or optimum harvest. Maturity levels at harvest are described in Table 1.

Two bushel samples of each variety were processed and analyzed immediately after harvest. The rest were separated into two equal quantities, one of which was stored at 34°F and the other in a common storage room. The common storage room was ventilated automatically whenever the outdoor temperature dropped more than 3°F below the indoor temperature. Temperature and humidity were recorded in common storage and the temperature summations in degree-days above a 30°F base line were calculated.

Apples were removed from the storages, for processing and analysis, on the basis of 25, 50, 75 and 100% of their average expected storage life. Storage intervals between sampling days and total storage periods are shown in Table 1.

Laboratory Procedures—A 40-apple sample for laboratory analysis

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[2]This work was done under contract No. 12–14–100–473 (73) with the United States Department of Agriculture, Eastern Utilization Research and Development Division, Philadelphia, Pennsylvania.

Table 1.—Description of mean maturity levels of raw apples at harvest and storage intervals. (1955)

Variety	Shear press	Titratable acidity	Soluble solids	Ascorbic acid mg/100	Storage intervals between sampling days		Total storage period days	
					Cold	Common	Cold	Common
	lbs.	%	%	gms				
Stayman	678	.61	10.6	12.5	33	16	132	64
Golden Delicious	596	.39	12.2	7.3	26	14	104	56
York Imperial	757	.43	8.5	7.9	33	20	132	80
Rome Beauty	704	.31	11.1	6.2	33	20	132	80
Northwest Greening	1077	.48	6.2	8.9	33	20	132	80

was selected at random from each two bushel group.

Pressure tests using a Magness and Taylor tester were made on each apple (4). A random 150 gram sample of peeled, cored and trimmed slices from the 40 apples, was placed in the standard Maryland shear-press 10 blade-grid cell, with the slices at right angles to the blades. Shearing speed was adjusted to a setting of 4 on the flow control valve.

Titratable acidity using phenolphthalein, ascorbic acid using indophenol dye, pH, soluble solids, total solids, alcohol insoluble solids (AIS) total, acid soluble and water soluble pectins, expressed as anhydrogalacturonic acid (1), (6), total sugars (5) and sugar-acid ratio were determined on each lot prior to processing.

Pilot Plant Procedures—After machine peeling and coring the raw apples were immediately trimmed, sliced and placed in a 3 per cent NaCl solution. The slices were then flushed with cold water and placed in an upright retort in blanching baskets for pre-cooking. Juice cooked out of the tissues was caught for later add-back to the sauce. The slices were held in the retort at 225°F for 4 minutes.

After pre-cooking, slices were pulped in a screw type extractor with $^1/_{16}$" screen openings, placed in a 5-gallon aluminum steam jacketed kettle and heated to 190°F. At this point sugar was added to an end-point of about 18% soluble solids and enough water was added to standardize flow (consistency) at 10–11 on the Adams Consistometer.

The prepared sauce was filled into No. 1 cans, which were closed, given a 3-minute cook in boiling water and cooled immediately. All samples were stored at room temperature for later evaluation.

Organoleptic Evaluation—Sauce was evaluated organoleptically for the various quality factors by an industry type panel comprised of industry members, Agricultural Marketing Service inspectors and local food technologists. They evaluated the sauces first from the overall grade standpoint considering the factors of flavor, color, texture and consistency. They used a 10-part scale, with 1—5 being standard and 6—10 fancy quality. Then each panel member scored the samples for the above individual quality factors.

Statistical Evaluation—Statistical procedures were used according to Snedecor (7). An unpublished method by Amihud Kramer of

this department after Snedecor (7) was used for determination of partial regression coefficients.

1956–57 Season

Raw Product Handling—The Northwest Greening was dropped from the study because of poor quality and Jonathan was added. The apples were harvested, stored and sampled as described for 1955–56 except that all varieties were picked at three stages of maturity, pre-optimum (early), optimum (medium) and post -optimum (late) harvest. Maturity levels at harvest are described in Table 2.

Table 2.—Description of mean maturity levels of raw apples at harvest. (1956).

Variety	Shear-press lbs. force	Titratable acidity %	Soluble solids	Ascorbic acid mg/100 gms
Stayman				
Early	580	.70	11.2	11.03
Medium	555	.71	13.6	13.84
Late	438	.65	16.5	4.89
Golden Delicious				
Early	595	.53	13.5	7.03
Medium	467	.55	15.8	10.54
Late	362	.47	15.5	10.20
York Imperial				
Early	672	.52	11.1	9.73
Medium	569	.54	11.9	8.94
Late	485	.43	13.5	6.24
Rome Beauty				
Early	650	.40	13.2	8.27
Medium	460	.33	12.5	5.81
Late	435	.27	12.3	4.49
Jonathan				
Early	601	.99	11.8	11.97
Medium	626	.80	14.8	13.77
Late	533	.76	14.9	13.12

Storage intervals for all varieties except Jonathan are shown in Table 1. The Jonathan samples were held 24 days between cold storage periods and 13 days between common storage periods. Total storage was 96 days in cold and 52 days in common.

Laboratory and Processing Procedures—Both were carried out as in 1955–56.

Organoleptic Evaluation—Evaluations used in 1955–56 were continued in 1956–57 except a plus or minus scale was used to measure consistency of the processed sauce. The scale was as follows: +4 extremely thick, +3 much too thick, +2 too thick, +1 slightly too thick, 0 ideal consistency, −1 slightly too thin, −2 too thin, −3 much too thin, −4 extremely thin.

Color of the canned sauce was measured by the Hunter Color and Color difference meter using the ivory plate SKC–SBC #31 L=76.2, a_L =−1.1, and b_L = +23.4.

1957–58 Sauce Blends

Raw Product Handling—Four of the best single sauce varieties, Stayman, Golden Delicious, York Imperial and Jonathan were

selected for a sauce blending program. Early and medium maturity and storages which exhibited good sauce characteristic in previous years were blended where practical. Otherwise the apples were handled as described under 1955–56–57.

Processing Procedures—Varieties were blended prior to processing as whole unpeeled apples in 1:1, 2:1:1, 1:2:1, 1:1:2 and 1:1:1 ratios with never more than three varieties per blend.

Finished Product Evaluation—This was carried out as in 1956–57. Gloss of the sauce was measured with the Hunter Glossmeter using a 60° angle. A separate group of chain store buyers also evaluated the samples for quality.

Results and Discussion

The mean quality evaluation of canned apple sauce is reported in Tables 3–6. Scores of 15 judges were pooled for analysis. Only main effects are presented. No attempt will be made to discuss each treatment in detail.

Single Variety Sauce

Variety Effect—Mean values for each variety including all maturities, storage types and storage duration are given in Table 3.

The sauces except Northwest Greening were rather close for most quality attributes. Golden Delicious sauces appeared to have a bright golden color. York Imperial was grainy in texture. Northwest Greening ranked low in all factors, especially color. Sauce ranking by overall scores was Golden Delicious, York Imperial, Jonathan, Stayman, Rome Beauty and Northwest Greening.

Effect of Duration of Storage—(Table 4)—In 1955–56 color of

Table 3.—Effect of variety on apple sauce quality—single variety sauce[a].

Variety	Color rating	Texture rating	Flavor rating	Consistency rating	Overall quality rating
1955–56 both storages					
Stayman	6.9	7.1	6.7	7.2	6.7
Golden Del.	7.9	7.6	6.8	7.4	7.0
York Imp.	7.7	7.5	6.5	7.2	7.1
Rome Beauty	7.7	7.3	6.5	7.1	6.9
N.W. Greening	3.3	6.0	5.3	5.7	3.7
LSD 5% Level	0.3	0.4	0.4	0.4	0.4
LSD 1% Level	0.4	0.5	0.6	0.6	0.7
1956–57 cold storage					
Stayman	7.2	—	6.4	—	6.7
Golden Del.	7.9	—	6.6	—	7.3
York Imp.	6.8	—	6.3	—	6.6
Rome Beauty	5.7	—	5.9	—	5.7
Jonathan	7.3	—	6.3	—	6.9
LSD 5% Level	0.5	ns	0.4	ns	0.6
LSD 1% Level	0.7	ns	0.5	ns	0.8
1956–57 common storage					
Stayman	7.2	—	6.4	—	6.8
Golden Del.	7.8	—	6.5	—	7.2
York Imp.	6.9	—	6.4	—	6.4
Rome Beauty	6.0	—	5.9	—	6.0
Jonathan	7.4	—	6.4	—	7.0
LSD 5% Level	0.7	ns	0.4	ns	0.7
LSD 1% Level	0.9	ns	ns	ns	ns

[a]10, 9, 8, 7, 6, Fancy; 5, 4, 3, 2, 1, Standard.

Table 4.—Effect of storage duration on apple sauce quality—single variety sauce.

Storage duration	Color	Texture	Flavor	Consistency	Overall quality
1955–56 season					
As harvested	6.0	6.4	5.7	5.9	5.4
After 1 storage period	6.8	7.2	6.6	7.0	6.4
After 2 storage periods	7.2	7.3	6.4	7.3	6.7
After 3 storage periods	6.7	7.3	6.4	7.3	6.5
After 4 storage periods	6.7	7.3	6.6	7.2	6.4
LSD 5% Level	0.3	0.4	0.4	0.4	0.4
LSD 1% Level	0.4	0.5	0.6	0.6	0.6
1956–57 cold storage					
As harvested	7.2	—	6.3	8.1	6.8
After 1 storage period	7.3	—	6.5	8.8	6.7
After 2 storage periods	7.4	—	6.6	9.1	7.1
After 3 storage periods	7.1	—	6.3	9.4	6.7
After 4 storage periods	6.0	—	5.8	9.2	5.9
LSD 5% Level	0.5	ns	0.4	0.8	0.6
LSD 1% Level	0.7	ns	0.5	—	0.8
1956–57 common storage					
As harvested	—	—	—	8.1	—
After 1 storage period	—	—	—	9.0	—
After 2 storage periods	—	—	—	9.4	—
After 3 storage periods	—	—	—	9.0	—
After 4 storage periods	—	—	—	9.2	—
LSD 5% Level	ns	ns	ns	0.6	ns
LSD 1% Level	ns	ns	ns	0.8	ns

Table 5.—Effect of maturity on apple sauce quality—single variety sauce.

	Color	Texture	Flavor	Consistency	Overall quality
1956–57 cold storage					
Early	6.7	—	—	—	—
Medium	7.0	—	—	—	—
Late	7.2	—	—	—	—
LSD 5% Level	0.4	ns	ns	ns	ns
LSD 1% Level	ns	ns	ns	ns	ns
1956–57 common storage					
Early	6.5	6.7	—	—	6.2
Medium	7.3	7.2	—	—	6.9
Late	7.4	7.4	—	—	7.0
LSD 5% Level	0.5	0.3	ns	ns	0.5
LSD 1% Level	0.7	0.4	ns	ns	0.7

Table 6.—Top rated apple sauce blends 1957–58.

	Ratio	Score
1. York 1st period common storage, Medium harvest	1	
Jonathan 2nd period cold storage, Medium harvest	1	8.2
2. York 1st period common storage, Early harvest	2	
Stayman 2nd period common storage, Early harvest	1	
Golden Delicious 2nd period common storage, Medium harvest	1	8.0
3. Golden Delicious 2nd period cold storage, Medium harvest	1	
Stayman 2nd period cold storage, Medium harvest	2	
York 3rd period common storage, Early harvest	1	7.9
4. Same blend as 3	2	
	1	
	1	7.2
5. Golden Delicious 2nd period cold storage, Medium harvest	1	
Stayman 2nd cold storage, Early harvest	1	7.6
6. Jonathan 2nd period common storage, Medium harvest	1	
Golden Delicious 2nd period common storage, Early harvest	1	
Stayman as harvested, Medium harvest	2	7.4
7. Same blend as 3	2	
	1	
	1	7.2
8. Jonathan 4th period cold storage, Early harvest	2	
York 2nd period cold storage, Medium harvest	1	
Stayman 3rd period cold storage, Medium harvest	1	7.2
LSD 5% Level		1.0

canned sauce improved with increasing duration of storage to about 50 per cent of the expected storage life. The same trend appeared in 1956–57. Texture in 1955–56 improved with increased storage duration. Flavor did not change much except that sauce from apples freshly harvested and from very long storage tended to be lower in flavor scores. Although consistency was controlled throughout the study to 10–11 on the Adams consistometer, sauce from apples processed at harvest tended to be thicker than other samples.

Apples held to about 50 per cent of their expected storage life made sauce with the highest overall scores, after which sauce quality decreased as storage periods increased.

Storage Type Effect—During the two seasons cold storage and common storage were roughly equivalent. Most varieties were held in common storage a little more than half of their expected maximum cold storage life. Color of the apple sauce was slightly better in common storage and texture was better in cold storage.

Temperature accumulations in common storage above a 30°F base line were as follows: Fall 1955 September 15–30—373, September 15–October 31—940, September 15–November 30—1179; Fall 1956 September 15–30—430, September 15–October 31—1163, September 15–November 30—1465 degree days. In the fall 1956 by October 31 the apples had received as many degree days of temperature as the apples in 1955 had received by November 30.

Picking Maturity Effect—(Table 5)—Color in both cold and common storage, and texture, and overall scores in common storage increased with the use of apples from increased maturity levels. Results indicated that the more mature the apple at a commercial picking level the more desirable the processed sauce, especially if processing is immediate and not after storage.

Sauce Blends

Fifty blends were made from the 4 varieties which showed good sauce characteristics in the first two seasons of study (Table 6). It was very difficult to ascertain the factors of quality each individual variety was contributing to an apple sauce blend.

A 50–50 blend of Jonathan and York received the top score of 8.2 assigned by the industry group. This blend had good color, flavor and a slightly grainy texture. The York based on past experience added graininess, and both varieties at this stage of maturity and storage were bright golden in color. The acidity of the Jonathan contributed to the tartness which was considered desirable in sauce.

A Golden Delicious, Stayman, York blend with slightly different ratios of the varieties held 3 out of the 8 top placements. The apples were about 50 per cent of the way through their respective storage periods with two varieties from a medium harvest and one from an early harvest.

In apple sauce blending, with varieties studied, Golden Delicious contributed bright, golden color and a high solids content, York Imperial added grainy texture and golden color, Stayman added

high solids and high acidity, and Jonathan added a very high acidity and a golden color.

Raw Product—Sauce Quality Relationships

Raw quality measurements[3] *and sauce quality factors.* Data from this study, which are not included in tables showed that there was generally a poor relationship between raw apple tests and sauce quality, probably because in sauce making the identity of the raw apple is almost completely lost in cooking, pulping, and addition of sugar and water.

Specifications for buying raw apples for sauce probably should include some texture measurement to control maximum firmness or hardness and a minimum per cent soluble solids to evaluate the sugar content. Control or measurement of maximum firmness would ease the pre-cooking problem of immature apples and insure against an extremely grainy sauce. The maximum allowable shear-press values for sauce should be around 700–750 lbs. force. In the Appalachian area, apples with soluble solids much less than 10 per cent will not make good sauce unless they are allowed to ripen in storage.

Sauce Quality Relationships 1955–56 season (Tables 7 and 8)

These correlation coefficients are derived from the industry type panel scores. The single correlations show a high relationship between color and the overall scores. Color alone was quite indicative of overall sauce quality. There were also rather high correlations between several other sauce quality factors which indicated the difficulty of conducting a completely unbiased panel.

From the coefficient of determination it can be seen that 96.4% of the variation of overall scores can be attributed to color, texture, flavor and consistency of the sauce. The multiple correlation coefficient (.982) shows improvement over the use of color alone to predict quality.

From the b values for each quality factor studied, one may determine the amount each contributes independently to the overall quality picture. In Table 8 the percentages attributed to each quality factor are shown. Color was by far the most important factor. Since the coefficient of determination was so high (96.4%) this estimate of the relative importance of these factors is probably very close to actual industry grading practices and indicates what they think buyers and in turn the consumers want in apple sauce.

1956–57 season (Tables 7 and 8)

The single correlations indicate a fairly high degree of correlation between the flavor and color and the overall grade.

From the coefficient of determination, it can be seen that 65.7% of the variation in overall scores can be attributed to color, texture, flavor and consistency. The multiple correlation coefficient (.811)

[3]These data included in a paper by Wiley and Thompson (8).

Table 7.—Simple and multiple correlations between apple sauce quality factors. Single variety sauces.

Quality factors	1955–56	1956–57
	r	r
Color vs overall quality	+.954	+.734
Texture vs overall quality	+.847	+.543
Flavor vs overall quality	+.687	+.775
Consistency vs overall quality	+.873	+.221
Color vs texture	+.773	+.446
Color vs flavor	+.796	+.790
Color vs consistency	+.590	+.216
Texture vs flavor	+.825	+.554
Texture vs consistency	+.537	+.237
R^2	.964	.657
R	.982	.811

Table 8.—Approximate relative importance of sauce quality factors when related to overall scores.

	1955–56	1956–57
Color	56.1%	33.3%
Texture	11.9%	16.3%
Flavor	19.7%	47.1%
Consistency	12.2%	3.3%

shows some improvement over the use of flavor or color scores alone in predicting overall sauce quality.

From the b values for each quality factor, flavor was most important, followed by color and texture. Consistency was again low in relative importance.

1957–58 season (Tables 9 and 10)

Industry Panel—This relationship refers to the 50 apple sauce blends as graded by the industry panel. Color and flavor had a high correlation with overall scores. It can be seen that 67.7% of the variation in overall scores can be attributed to color, texture, flavor and consistency. The multiple correlation (.823) is a con-

Table 9.—Single and multiple correlation between apple sauce quality factors—blends—1957–58.

Factors		Industry panel	Buyers panel
Color	vs overall quality	+.727	+.630
Texture	vs overall quality	+.620	+.488
Flavor	vs overall quality	+.715	+.346
Consistency	vs overall quality	+.313	+.095
Color	vs texture	+.659	+.466
Color	vs flavor	+.546	+.496
Color	vs consistency	+.359	−.070
Texture	vs flavor	+.593	+.314
Texture	vs consistency	+.324	−.002
Flavor	vs consistency	+.328	+.055
	R^2 =	.677	.462
	R =	.823	.680

Table 10.—Approximate relative importance of sauce quality factors when related to overall quality. 1957–58.

	Industry	Chain store buyers
Color	46.6%	71.4%
Texture	7.2%	25.5%
Flavor	44.8%	0.2%
Consistency	1.4%	2.9%

siderable improvement over color alone in predicting the overall score of grade.

In Table 10 calculations from the b values in the multiple correlations show color and flavor to be about equal in importance of apple sauce grading. Texture and consistency were of small importance.

Buyers Panel—A group of chain store buyers also evaluated the same 50 blends of apple sauce. Their panel evaluations show more emphasis on color than any other factor in relation to overall scores. From the coefficient of determination only 46.2% of the variation of overall scores can be attributed to color, texture, flavor and consistency of the sauce.

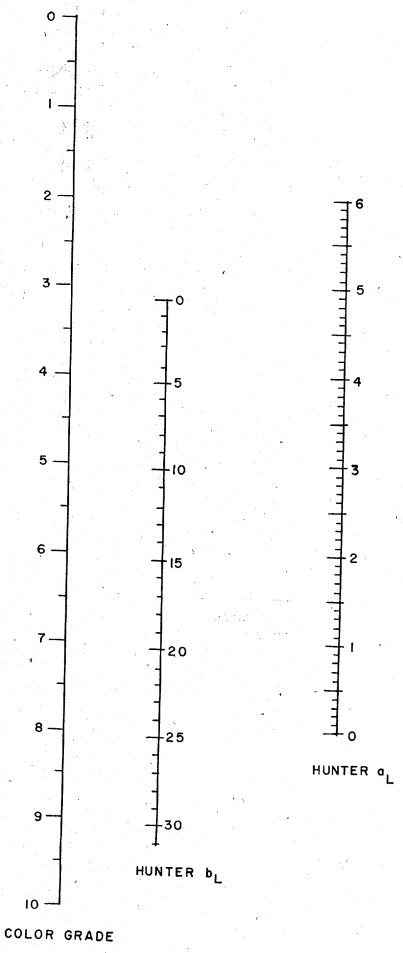

Fig. 1. Nomograph to predict color scores of canned apple sauce from Hunter a and b values.

The b values for each quality factor indicate the great emphasis on color and a lack of emphasis on flavor. Texture also appears important. Buyers indicated that a bright color and a slightly grainy texture were important characteristics of good sauce. They appeared to prefer sauces heavy in body or consistency.

Objective Color Grade, 1956–57 (Table 11)—Since there appeared to be considerable emphasis in the color of canned apple sauce the Hunter Color Meter was employed to grade the sauce objectively.

From the coefficient of determination, with or without Hunter L in the multiple correlation, the instrument was not able to account for more than 51–52% of the variation in color scores by panel. To place scoring on an objective basis two multiple regression equations are proposed for grading canned sauce. The second equation is presented graphically in Fig. 1 since it is the simplest to operate. It can be used to indicate relative color grade of a sauce and cannot be used for direct assignment of grade because of the low R^2 and R values in correlation surface.

Table 11.—Single and multiple correlation between Hunter Color Difference Meter readings and color scores for apple sauce assigned by industry. 1956–57.

Factors	
Color score vs Hunter a_L	+.244
Color score vs Hunter b_L	+.594
Color score vs Hunter L	+.145
a_L vs b_L	−.238
a_L vs L	+.353
b_L vs L	−.132
R^2 =	.519
R =	.721
Drop Hunter L from correlation	
Color score vs Hunter a_L	+.244
Color score vs Hunter b_L	+.594
a_L vs b_L	−.238
R^2 =	.510
R =	.714

Multiple regression equation for predicting color grade of canned apple sauce from Hunter L, a_L, and b_L, readings

(1) Color grade = $-2.21 + 0.06L + 0.479a_L + 0.307b_L$

From Hunter a_L and b_L readings.

(2) Color grade = $0.560 + .530a_L + 0.305b_L$

1957–58 (Table 12)—In the final year of the study the sauce color measurement was continued on blends in order to improve efficiency of the method. In Table 12 Hunter Color Meter readings accounted for about 50 per cent of the variation in color scores assigned by the panels. The use of Hunter L did not affect the correlation to any great extent.

Since some panel members indicated gloss of the sauce was influencing their scores, a gloss reading with the Hunter Glossmeter was included with Hunter L, a_L b_L. The ensuing multiple correlation accounted for about 10 per cent more of the variation in color

Table 12.—Single and multiple correlations between Hunter Color Difference Meter readings and color score for apple sauce assigned by industry. 1957–58.

A — Factors	r
Color score vs Hunter a_L	+.552
Color score vs Hunter b_L	+.220
Color score vs Hunter L	+.195
a_L vs b_L	−.330
a_L vs L	−.006
b_L vs L	+.665
R^2 =	.498
R =	.706
B — Drop Hunter L from correlations	
Color score vs Hunter a_L	+.552
Color score vs Hunter b_L	+.220
a_L vs b_L	−.330
R^2 =	.486
R =	.690
C — Add Hunter Gloss Reading to Hunter L, a_L, b_L	
Same as A through b_L vs L	+.457
Color score vs Hunter Gloss	+.383
a_L vs Hunter Gloss	−.243
b_L vs Hunter Gloss	−.372
L vs Hunter Gloss	.000
R^2 =	.585
R =	.776

scores. This approach appears to show promise and deserves further study.

Summary and Conclusions

The following conclusions can be drawn from the results of this three-year study:

1. Varieties for sauce in this study are ranked as follows: Golden Delicious, York Imperial, Jonathan, Stayman, Rome Beauty and Northwest Greening.
   Outstanding features of the top 4 varieties are: Golden Delicious, bright golden color and high solids content; York Imperial, grainy texture and good color; Jonathan, very high acidity and bright color; Stayman, high acidity, high solids content and high pectic constituents. Rome Beauty was intermediate in quality and Northwest Greening was generally low in quality as a single variety sauce.
2. In either common or cold storage, duration of storage had a pronounced affect on sauce quality. Apples harvested in the early maturity range required 1–2 months to reach their peak quality levels. Those harvested at medium harvest levels and those at a late level generally declined in sauce quality with increasing duration of storage.
3. Sauces made from apples held in storage i.e. common or cold, were approximately equivalent in quality when the common storage durations were about half of the cold storage periods. Length of common storage, however, should be carefully regulated according to seasonal temperature and the apples held in this manner should be processed prior to excessive heat unit accumulations.
4. Scores showed the more mature the apple at harvest the higher the quality of the resultant sauce. This was especially true for the factors of color, texture and the overall grade of the sauce.
5. Sauce blend results showed that a 50–50 blend of Jonathan and York exhibited the highest panel scores. The apples were sauced after 1–2 months in cold storage. Golden Delicious, Stayman and York in varying proportions from 1–2 months storage and early and medium harvests were also excellent blends.
6. The use of raw apple quality tests to predict the quality of canned sauce were disappointing. This may be because the raw apples are cooked, pulped, and have sugar and water added before manufacture. It is suggested, however, for the Appalachian area that maximum firmness levels for apples for sauce should be set at 700–750 lbs. force shear-press and the minimum per cent soluble solids level of about 10 per cent. These two requirements should adequately control problems in texture, color and flavor.
7. About 76.6% of the variation in the overall scores of apple sauce by industry panels were accounted for by the quality factors of color, texture, flavor and consistency. Color ac-

counted for 45 per cent, texture 12 per cent, flavor 37 per cent and consistency 6 per cent of the grade.

8. The chain store buyer's panel evaluating blends of one season's pack accounted for about 50 per cent of the variation in overall scores. Although all the variation in sauce grades was not covered by their evaluations certain trends are shown. Color accounted for 71 per cent of the grade, texture 25 per cent, flavor 1 per cent and consistency 3 per cent. Chain store buyer's preferences would indicate industry sauce packers may not be putting enough emphasis on color and texture and are perhaps too concerned about flavor.
9. The use of the Hunter Color and Color Difference Meter to grade color of canned sauce accounted for only about 50 per cent of the variation in panel color scores. Use of Hunter a_L b_L in the following multiple regression equation: color grade= $0.560 + 0.530\ a_L + 0.305\ b_L$ was found to be as efficient as using Hunter L, a_L and b_L together. The addition of a gloss reading by the Hunter Glossmeter (60° angle) accounted for another 10 per cent of the variation in color grade but does not completely overcome the canned apple sauce color grading problem.

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